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ABSTRACT

A multimedia, self-paced, individualized instructional program was designed to meet the needs of students in air conditioning, refrigeration, and heating programs at Oil Belt Vocational Technical School (Arkansas). The multimedia approach provided for video-based presentations to meet the needs for visual contact with the classroom and for efficient presentation of visual resources. Self-paced learning packets were developed using a 16-step process, beginning with the acquisition of equipment, identification of resources, taping of presentations, identification of step-by-step procedures to be followed by students, and monitoring and evaluation of use of materials developed. Two complete courses were developed in the self-paced, individualized format, but use of the courses has been limited. The procedure identified for developing learning materials and for managing the learning process serves as a guide for other instructors. The equipment and expertise developed through the project has benefited instructors in creating lessons for reinforcement and for more challenge to students. Although learning materials developed are expected to be helpful, the project was not as successful as expected because of the quality of instructors used as presenters, the time required of the instructors to plan and produce visual materials, and the difficulty encountered in transferring one-on-one training to a written, individualized program. (Two thirds of the document consists of appendices containing written materials for the self-paced learning program, such as job sheets, tests, and answer sheets, and program budget.) (KC)

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Arkansas Department of Education

FINAL REPORT

MULTIMEDIA APPROACH TO SELF-PACED INDIVIDUALIZED INSTRUCTION IN AIR CONDITIONING, REFRIGERATION AND HEATING AND OTHER VOCATIONAL PROGRAMS

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Conducted by

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El Dorado, Arkansas
Ronda Leach, Project Director

In Cooperation with
Vocational and Technical Education Division
Arkansas Department of Education
Little Rock, Akansas 72201

Funded under the Provisions of
P.L. 98-524

July, 1989

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Votech

July 28, 1989

Ms. Deborah S. Walz
Program Improvement Administrator
Arkansas Department of Education
Three Capitol Mall
Little Rock, AR 72201-1083

Dear Ms. Walz:

Enclosed in the final report of the Program Improvement Project entitled "Multimedia Self-Paced Individualized Instruction in Air Conditioning, Heating and Refrigeration and Other Vocational Programs."

Although, we feel the project has not been as successful as anticipated, we have a better understanding and appreciation for the time and expertise needed for such a project.

The project has provided us an opportunity to test new ideas related to the development of self-paced individualized instruction. The video equipment and media development coordinator have expanded the resources available to all our instructors for developing enhancements to their programs.

We appreciate the opportunity to participate in this project.

Sincerely,

Jean C. Eckert
Media Project Coordinator

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ABSTRACT

MULTIMEDIA APPROACH TO SELF-PACED INDIVIDUALIZED INSTRUCTION IN AIR CONDITIONING, REFRIGERATION AND HEATING AND OTHER VOCATIONAL PROGRAMS

PROJECT BACKGROUND

A variety of self-paced individualized instructional programs are being used to meet the needs of students at the post-secondary level. It was determined that a unified program of managing and developing such a program would provide a standard for the development of other courses. The multi-media approach provided for video-based presentation to meet the needs for visual contact with the classroom and for efficient presentation of visual resources.

METHODOLOGY

Self-paced learning packets were developed using a sixteen step process, beginning with the acquisition of equipment, identification of resources, taping of presentations, identifying step-by-step procedure to be followed by the student, and the monitoring and evaluating of use of materials developed.

RESULTS

Two complete courses were developed in the self-paced individualized format, but use of the courses has been only limited at the time of this report. The procedure identified for developing learning materials and for managing the learning process in a self-paced environment provides an easy guide for other instructor to follow. The equipment and expertise developed through the project has proved beneficial to instructors in developing specific lessons to meet the needs of slower students for reinforcement and also to provide challenges to more advanced students. Although learning materials developed will be helpful, the project was not as successful as expected because of the quality of instructors used as presenters, the time required of the instructors to plan and produce quality visual materials, and also the difficulty encountered in transferring one-on-one training to an written, individualized program.

SUMMARY

The multimedia approach to self-paced individualized instruction enhances this type of program, but quality instructors are needed who understand the concept of

individualized instruction and the video medium. Full time instructors are limited in the time they can devote to developing, testing, and managing a video-based individualized program.

RECOMMENDATIONS

Video -based instruction is only effective if done well. In order to produce an effective learning package, expertise in video production is needed. Secondly, instructors to be used should be selected carefully for communication skills and organizational ability. Also, courses should be selected for their adaptability to individualized learning. Finally, a generous allotment of time on the part of the instructor is necessary to develop quality materials. Although quality professionally prepared video material is expensive, the cost of incorporating this resource with instructor prepared material might prove more beneficial in the long run.

FINAL REPORT

MULTIMEDIA APPROACH

TO

SELF-PACED INDIVIDUALIZED INSTRUCTION

PROJECT BACKGROUND

The Problem:

Vocational technical education has addressed the individual needs of students for many years. Substantial work has been done in the past few years to refine and develop task accomplishments, competency profiles, and standardized curriculum. These developments have necessitated a change in instruction methods to meet individual student needs.

Students enter post-secondary vocational technical schools at varying stages of development and experience. It is difficult to determine when the student has mastered the knowledge and skills necessary for successful entry into the occupation of his or her choice.

Testing programs operated at Oil Belt Vocational Technical School indicate a wide range of abilities and

aptitudes of applicants. Among the applicants for enrollment in the Air Conditioning, Refrigeration and Heating program, some have high levels of ability and aptitude; however, the applicant with lower skills and aptitude must also receive service and training. This range of abilities and aptitude creates problems for all levels of students. The more gifted students become bored as training is scaled down to the accepted normal rate of progression while the slower students are frustrated at their inability to keep pace with their peers.

The middle range of students also have problems relating to the input and distractions created by the gifted and slower students. It is widely accepted theory that students are more successful and motivated when they can progress at their own speed. The 1980 AVA Yearbook develops a strong case for customized training programs based on the realities of the job market and student abilities. A variety of programs based on the individualized learning concept have been tried by instructors at Oil Belt Vo-Tech in an attempt to fill this void.

Need:

The current system results in less than full utilization of facilities and resources making the concurrent development

of a successful self-paced individualized program essential if training is to be efficient and cost effective.

Generally, students are accepted into Oil Belt Vo-Tech regardless of their ability and an individualized program of study is developed where necessary to upgrade math and communication skills. The instructor of the particular training program must then provide gifted students additional challenges and slower students more supervised instruction in their training area.

Recent writings and reports from around the nation indicate a great deal of interest and enthusiasm for the concept of self-paced individualized instruction. A variety of programs are being implemented successfully, but review of these projects indicates less than uniformity and unanimity of opinion and procedure for implementation. This has been true at Oil Belt Vo-Tech.

Although a variety of procedures for the use of self-paced individualized instruction are currently being used by Oil Belt Vo-Tech instructors, there was a need for improving, refining, and standardizing the instructional procedure to meet task accomplishments, competency profiles, and the standardized curriculum in the Air Conditioning, Refrigeration and Heating Program.

MULTIMEDIA FOR INDIVIDUALIZED INSTRUCTION
Final Report

Purpose:

The major purpose of the project was to design, develop, field test, refine, implement and disseminate a management and instructional system for the self-paced individualized instruction of students in Air Conditioning, Refrigeration, and Heating Program. A secondary purpose was to involve other programs at Oil Belt Vo-Tech in the development of the concept based on available time and resources as requested by instructors.

Expected Results:

The project was designed to develop, field test, implement and disseminate a management system and support materials that would accommodate the self-paced individualized concept in Air Conditioning, Refrigeration and Heating.

Specific Objectives were:

1. Develop management system for self-paced individualized instruction.
2. Identify instructional materials available for individualized training.
3. Develop materials suitable for the self-paced concept.
4. Develop evaluation instruments that would assure occupational competence for students.

5. Implement a field test designed to evaluate and further refine methods and materials.

6. Disseminate results and recommendations for implementation of the program at other locations.

Limitations:

At the time Oil Belt Vo-Tech began the project, a similar project had been in operation for one year. Quality examples and training for the coordinator were not available. A turnover of personnel after the first year, the middle of the two year project, resulted in another adjustment and orientation period for yet another untrained coordinator. A major factor in the program has been the selection of instructors utilized and the time and organization needed to successfully develop quality presentations.

METHODOLOGY

The multimedia approach to developing self-paced individualized instruction provided the opportunity to incorporate visual presentation of learning materials. Video tape provided the medium for reproducing lectures with presentation graphics including overhead projected materials, flipcharts, models and objects used in demonstrations.

A sixteen step procedure was identified to ensure comprehensive development of learning materials. The steps were outlined as follow:

Step 1. Equipment: Purchasing equipment, resources, and supplies to support instruction and media of delivery of instructions.

Step 2. Outline: Defining sequence of instruction and performance objectives.

Step 3. Video Tape: Taping of classroom lectures in their entirety including student interaction. Supplementary materials related to the unit were also presented on tape to insure easy access to the materials by the learner.

Step 4. Write: Reinforcement through written restatement of key ideas and the testing of understanding of these ideas by the student through a series of written questions for self-check by the student of his or her comprehension.

Step 5. Check: A check of key ideas within presentation to determine logical breaks in the learning materials. Segments were designed to be no longer than 45 minutes.

Step 6. Color Code: Taped segments were color coded with accompanying written materials for easy identification.

Step 7. Select Visuals: Ideally, graphics were to be designed to accompany every type-written page. These included hardcopy of chalkboard presentation or alternate designs corresponding to textbook diagrams.

Step 8. Type: All materials to be included in the written package were attractively formatted and placed into transparent sheet protectors and placed in ring binders, labeled and coded to correspond to accompanying tape presentations.

Step 9. Duplicate: Numbered worksheets for recording student responses were duplicated on colored paper for easy selection with answer sheets provided where appropriate for self testing.

Step 10. Compile: Learning packages were compiled to include learning guide, materials checklist, work sheets, and answer sheets.

Step 11. Record: Originally, all written material was to be recorded for oral presentation to accommodate students with low reading levels. This was deleted when it was determined that it would not be necessary because of the ability level of students and the feasibility of such an extensive project.

Step 12. Videotape: The introduction to self-paced individualized instruction and procedure for successfully

using the packaged material was presented using this visual medium. Also, unit introductions and summaries were taped to provide the student direction, motivation, and final reinforcement which served to pull series of lessons into a comprehensive unit.

Step 13. Dubbing: Final editing and polishing of video presentation.

Step 14. Labelling and Storing: The packages were clearly labeled and stored in program classroom and library for easy access by all students.

Step 15. Orientation and Management: Instructors worked with students and coordinator to establish proper scheduling of student's time for use of individualized material and for appropriate instructor/student interaction.

Step 16. Monitoring and Evaluation: The coordinator developed instruments for recording use of the learning packages while the instructor kept individual student progress charts to determine progress and completion of occupational competencies. Instructor/Coordinator conferences were held regularly to gage progress and make any adjustments necessary for the students' benefit.

Learning packages compiled in step ten included:

a. Title of the unit
b. Performance objectives
c. Activity guides (consumable)
d. Pre-test

e. Programmed instructional sections
f. Worksheets (consumable)
g. Answer sheets (self-checking)
h. Post-test
i. Job sheet assignments
j. Video tapes of (a) lectures, (b) supplemental materials, and (c) demonstrations

The aim of the project was to provide the student a personal learning package using the visual medium of video tape. Thereby, providing a classroom setting with interaction from other students, the involvement in demonstrations, and the reinforcement of diagrams and classroom review. Also, additional resource material would be included in the video presentation, eliminating the need for time-consuming research on the part of the student.

Two layouts were used for the learning packages. (See Appendix A.) A professional training format was used by the first year coordinator, Mrs. Linda Wilson, for her packages on Air Conditioning/Refrigeration training. This package contained detailed notes with question/answers inserted following individual ideas. The second format followed examples provided in PBTE, series K, modules for Competency-Based Education. Both packages contained the items identified above, but the second format provided for more student/instructor contact. This was deemed important for student motivation and classroom interaction.

RESULTS

The project produced a self-paced learning program for ten units in Air Conditioning/Refrigeration and a self-paced individualized learning program for Basic Blueprint Reading course for students enrolled in Industrial Equipment Technology.

Video tape review session were developed on an individual topic basis providing reinforcement material on safety, use of the bench grinder, and electronic equipment. Other presentations were taped for reuse in the accounting, electronics, and nursing program. The taping of guest speakers, special hospital presentations, and hospital procedures proved beneficial to instructors for accommodating student schedules and enhancement of special studies in nursing.

The coordinator was able to provide video equipment and expertise to all instructors desiring to develop video enhancement for their particular self-paced learning materials and also for resource purposes.

The following is a breakdown of activities as these activities relate to the specific objectives of the project. The results have been evaluated through observation and

through review by the director, coordinator and instructors involved.

MULTIMEDIA APPROACH TO SELF-PACED INDIVIDUALIZED INSTRUCTION

Objectives	Activities	Evaluation
1. Develop management system.	1. Step by step procedure outlined.	1. Beneficial to instructors for developing complete learning packet.
	2. Control forms for checking progress of video tape developed.	2. Helpful in tracking progress but not used to its fullest.
	3. Records devised for recording use of learning packets.	3. Difficult to maintain because of flexible use of materials by students in two settings.
2. Identify instructional materials available for individualized training.	1. A listing of library and classroom materials was made.	1. A variety of resources is not available in the Air Conditioning/ Refrigeration program or the IET program because of changing technology and budget limitations.
	2. Although instructors could identify private and industry sources, these were not available to the student.	
3. Develop material suitable for self-paced concept.	1. Developing comprehension learning packets including pretest and posttest material with instruction for proceding through the activities until competency is achieved.	1. Learning packets were easy to follow and provide students direction.
4. Evaluation instruments that would assure occupational competence.	1. Final evaluation was required by instructor in shop situation.	1. Packet in Air Conditioning/ Refrigeration was not tested effectively in actual shop situation. Blueprint reading was more easily tested in written format and in production situation. Results were not pure because of interaction with other students.

Objectives	Activities	Evaluation
5. Implement a field test designed to evaluate and further refine methods and materials.	1. Students were asked to use packets when absent from school or when review was needed. This resulted in use of partial parts of packet, video, outline and questions.	1. Recording extent of use was difficult to determine.
6. Disseminate results and recommendations.	1. Sharing of knowledge, experience with programs in other schools who express an interest. 2. Preparation of this report.	1. Sharing knowledge is effective for preparing others to make decisions. 2. Circulation of self-paced video materials developed would not be advantageous because of the quality of instructors and the incorporating of copywrited materials.

Development of Self-Paced Learning Materials:

The process identified for developing materials with high visual appeal as well as being complete included:

Step 1. Outline lessons and identify resources

Step 2. Preparation for video presentation

Step 3. Videotaping of presentation and all possible suitable resources.

Step 4. Developing learning guides incorporating pre-test, study materials and assignments, reinforcement notes, resources, and post-test.

Step 5. Field test using part-time or currently enrolled students.

Step 6. Evaluation of student progress, process, and weaknesses of each for adjusting program.

Step 7. Disseminate self-paced learning packages and management information to other schools.

Evaluation of Development of Materials:

The outline of steps proved beneficial to organization and management of the project. The procedure was easy and logical for completion of units or individual assignments.

Each of the steps has their own set of circumstances to overcome. Basic to all steps was the need for cooperation of the instructor and coordinator. Although the project provided funds for an instructor's assistant, it was difficult for an instructor with total responsibility for a complete trade program to dedicate the time required for organization and a quality video presentation. Also, in programs requiring extensive hands-on training, it was difficult for the instructor accustomed to one-on-one oral instruction to translate these instructions to a written page in the form of questions or activity sheets.

In Step 1, outlining lessons was done easily. Usually, the instructor was able to provide the outline readily; resources were more difficult to identify. The instructor might have a variety of resources which were personal property, or might have access to resources borrowed from industry, but these resource were not available to the student. The cost of acquiring these resources was not practical for the school.

In Step 2, the preparation needed for video presentation depended upon the time available to the instructor. The instructors' first responsibility was to his current class. The result was insufficient preparation for effective video production. Much enhancement was recorded later for dubbing into presentation segments, but instructors were even more reluctant to spend further time on a previous lesson.

In Step 3, actual video taping was beneficial not only for its long-term effects but also for the significance that the media added to the lesson. Students perceived the instructor as more credible and deemed it necessary for themselves to stay interested (just in case the camera strayed to them).

Quality equipment was available through the project which added incentive to other instructors within the school to think about how they could use this resource more fully. It is evident that specific lessons have been developed for individualized presentation by other instructors because of the equipment and expertise available to them via the media project.

In Step 4, The format of the learning guides as originally designed was very efficient, copying the format used by many professional training publications. (See Appendix A.) With the beginning of the second year and the second

trainer, this format was evaluated as being too detailed by Dr. Bruce Simpson, Media Implementation Coordinator. Students needed guidelines for self-paced progression rather than detailed memorization. A new format was used for study-guide presentation. The first format was never tested effectively. It was used by a single student with multiple handicaps which precluded his demonstration in an actual shop situation of the tasks identified. The second format was used by five high school students to bring them up-to-date because of late enrollment in the post secondary program. Because the Air Condition/Refrigeration curriculum was more hands-on oriented and the high school students utilized the Basic Blueprint Reading course, it would not be a like comparison of materials.

In Step 5, fieldtesting turned out to be difficult. Students enrolled in the programs did not feel a need to review the lessons. One of the original objectives of the program was to serve the varying abilities and aptitudes of the students. Although students are attracted to the video medium, when time was allowed for individual study, they opted for hands-on work in the shop with peer direction or assistance rather than self-study using packaged lessons.

MULTIMEDIA FOR INDIVIDUALIZED INSTRUCTION
Final Report

SUMMARY

The self-paced individualized learning concept is valid and practical for meeting the needs of students of different abilities and at varying stages of learning.

The multimedia approach to self-paced individualized instruction project's objective was to develop an effective program of instruction for students in Air Conditioning and Refrigeration. The project expanded to include a course in Basic Blueprint Reading for students in the Industrial Equipment Technology Program, and for a variety of individual lessons as requested by instructors of other programs.

Complete learning packets were developed utilizing video-based presentations to provide students visual contact with the instructor and classroom.

Two formats for self-paced learning packets were used. A step by step process was outlined to identify the sequence for development of learning packages. This outline of the process was useful to other instructors in developing lessons on their own.

It was found that quality video presentations required considerable time and cooperation from the instructor. Since the instructor's first obligation was to his class, it was

difficult for him to dedicate the time necessary to development of presentations and visual aids.

Field testing of the learning programs was not effective because of the limited use made of the materials. Future students may benefit more since complete packages will be available on an individual review basis both in the classroom and in the library.

Dissemination of the actual package will be limited because of the instructor quality and the use of copyrighted materials included in the learning materials.

RECOMMENDATIONS

The self-paced learning concept requires a flexible instructor manager, because of the one-on-one time needed to meet the individual needs of the student. Video presentations are only effective if done well. Anything short of entertaining will not be effective use of the viewer's time and will be negative to the learning process. In order to develop and use a multimedia program for self-paced individualized program, the following considerations should be made:

First, a dedication to expertise or training. Training films done by professional video training companies are expensive because they use highly talented tradespeople and

professional broadcasters. These people understand the medium they are working with, the importance of speech, position relative to the camera, the effect of lighting, etc. Many good instructors do not have "stage presence." Their objective is to get an idea or concept across to a student using whatever means necessary. Pretrained experts or quality technical training should be provided to the video technician, instructor, coordinator, etc. The medium must be understood and utilized effective for effective results.

Second, instructors involved in a quality program, should be quality instructors; they should support the program fully and be willing to donate, over a long period of time, the time, talent, and organization necessary to make each lesson a worthwhile experience. Many instructors know their subject well and can give very good directions orally to students, but are unable to provide sufficiently detailed task procedures in written format. Each participant must have a desire to put the final outcome to use in order to develop a useful program.

Third, some topics are not appropriate for self-paced individualized instruction. Areas of study should be considered when selecting those which best lend themselves to a multimedia project.

Finally, a generous allowance of time is involved by all involved for planning, organizing, developing, and presenting.

Training Associates, Inc. suggest that ten hours of preparation is required for each one hour of training--and they are not including video production. This project requires a great deal of "out of classroom" work by the instructor/presenter.

A review of the cost of the program and its use should be made relative to the purchase of professionally prepared video instruction combined with on-site development of supplementary written instructional self-paced learning packets. (See Appendix B.)

The multimedia approach to self-paced learning concept can be an enhancement, but a dedication to quality presentations must be made to put together a complete course of study.

APPENDIX A

Written Materials

For Self-Paced Learning Program

AIR CONDITIONING AND REFRIGERATION

(ACR)

SYSTEM CHARGING

OIL BELT VO-TECH

INTRODUCTION

SYSTEM CHARGING

There are several ways of charging a refrigeration system. In this unit we will be discussing the two most common methods of charging; vapor charging and liquid charging. We will also discuss some of the equipment that is used in system charging, and some of the problems you can avoid by proper system charging methods. We will also discuss some often used alternative methods of charging: sight-glass charging and zero-point charging.

UNIT OBJECTIVES

When you have completed this unit, you should be able to:

1. Describe how refrigerant is charged into systems in the vapor and liquid states.
2. Describe system charging using two different weighing methods.
3. State the advantage of using electronic scales for weighing refrigerant into a system.
4. Describe a graduated cylinder.
5. Discuss zero-point charging and sight-glass charging.

This will be be evidenced by scoring 80% or better on the written posttest and performing the job sheet assignments to meet the criteria stated on the job sheet.

"SYSTEM CHARGING"

UNIT ACTIVITY GUIDE

_____Take the PRETEST on "System Charging" and check.

_____View the A/V presentation on "System Charging".

_____Do Programmed Instruction on "System Charging".

_____Do Job Sheets on "System Charging".

_____Take POSTTEST on "System Charging" and check.

PRETEST

SYSTEM CHARGING

1. Adding refrigerant to a refrigeration system
2. The type of charge which normally is put into the low side of the refrigeration system
3. A word meaning "outside" or "surrounding"
4. The more exact system of charging requires this piece of equipment
5. The charging method which is normally accomplished in the high side of the system
6. This sometimes causes the compressor to make a rattling noise.
7. For liquid charging, the drum should be
8. For vapor charging, the drum should be
9. To charge a system with a low pressure control, the low pressure contacts must be
10. Refrigerant is charged through this/these
11. One problem encountered in using scales to weigh refrigerant
12. This is necessary for expansion of refrigerant vapor.
13. Graduated
14. One thing not to be used in keeping pressure up in the refrigerant drum.
15. The simplest of the two alternate systems of charging
16. A variable charge system
17. A critical charge system
18. The part of the system that can be damaged by getting liquid refrigerant in it
19. Two alternate ways of charging, other than vapor charging and liquid charging are _____ and _____.

a. by-passed
b. compressor
c. torch
d. vapor
e. thermostatic expansion valve system
f. system charging
g. sight-glass charging
h. upside down
i. ambient
j. capillary tube system
k. numbered
l. service gages
m. upright
n. overcharging
o. graduated cylinder
p. 15% vapor space
q. calibration
r. liquid charging

SYSTEM CHARGING

PRETEST ANSWERS

1. f.
2. d.
3. i.
4. o.
5. r.
6. n.
7. h.
8. m.
9. a.
10. l.
11. q.
12. p.
13. k.
14. c.
15. g.
16. e.
17. j.
18. b.
19. zero-point charging and sight-glass charging

NOW: VIEW THE VIDEO ON SYSTEM CHARGING

SEE NEXT PAGE FOR ANSWERS

ACR

SYSTEM CHARGING

PROGRAMMED INSTRUCTION

1. Charging a system refers to adding refrigerant to a refrigerant system. Charging is a critical task in the refrigeration business because the correct charge must be maintained for proper, efficient operation of a refrigeration system.

   Adding the proper amount of refrigerant into a system is called _____ a system.

---

2. Refrigerant is the fluid in the refrigeration system that changes from a liquid to a vapor and back to a liquid at different pressures within the refrigeration system. Refrigerant can be charged into a system in either the liquid or the vapor state.

   Refrigerant is always charged into a system in the vapor state. (TRUE or FALSE)

---

1. charging
2. False

3. Charging a system in the vapor state is called vapor refrigerant charging. Vapor is almost always charged into the low pressure side of the refrigeration system.

   Vapor is almost always charged into a system on the _____ pressure side of the system.

---

4. Charging a system in the liquid state is called liquid refrigerant charging. It is normally accomplished in the liquid line on the high pressure side of the system.

   Charging a system in the liquid state is called what?

---

3. low
4. liquid refrigerant charging

---

5. Liquid refrigerant charging is sometimes referred to as dial-a-charge charging. This system requires the use of a graduated cylinder which is adjusted (or dialed) according to the pressure reading within the cylinder and according to the type of refrigerant used. The dial-a-charge system is the more exact system of charging.

   The dial-a-charge system refers to _____ refrigerant charging. (liquid, vapor)

---

6. When a system is not operating, vapor can be added to either the high or low pressure side of the system. When the system is running, however, vapor refrigerant may normally be added only to the low side of the system. This is so because of the pressure differences in each side of the system. Vapor charging is much slower than liquid charging.

   When the system is running, vapor can be added to either the high or the low side of the system. (TRUE or FALSE)

---

5. liquid
6. False

---

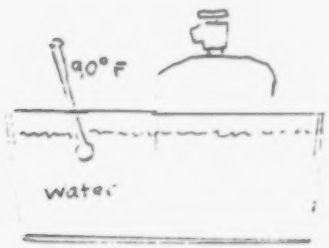
7. To add vapor into the low side of the system, the pressure in the refrigerant drum must be higher than the pressure in the low side. In the winter, this is sometimes a problem because of the cold, outside (ambient) temperature. Because of this, the drum will sometimes have to be heated to raise the inside pressure so that the vapor will travel into the system.

   During cold weather the drum pressure is _____.(higher, lower)

---

8. The safest way of heating a refrigerant drum to keep the vapor pressure up is placing the drum in a tub of warm (90°F) water. Another method is putting a heat lamp on the drum. Never use a torch to raise the vapor pressure. By doing this, the vapor pressure could be raised too high, causing the refrigerant drum to explode.

   The safest method of raising the drum pressure on a refrigerant drum is what?



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7. lower
8. Place drum in a tub of warm water.

---

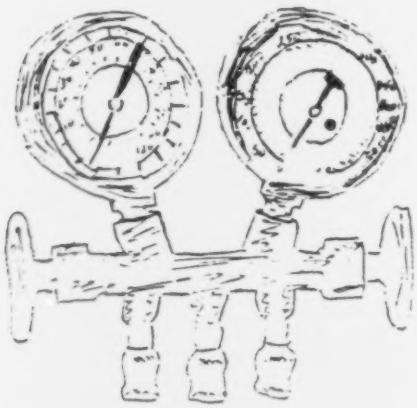
9. Vapor charging charges the system with an estimated amount of refrigerant. Liquid charging, however, is exact because the amount of liquid charged into the system is measured.

   The more exact of the two charging methods is the _____ charging method.

---

10. Refrigerant is charged through service gages. There are low-side gages and high-side gages.

    Refrigerant is charged through _____ _____.



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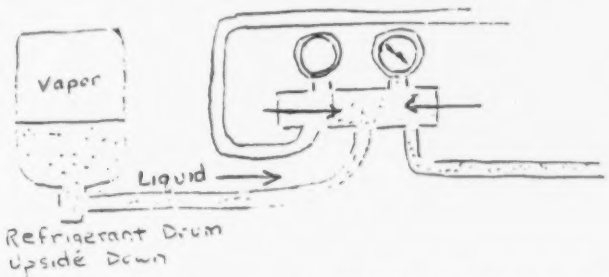
9. liquid
10. service gages

11. The liquid charge system advantage is that it is exact and the ambient (outside) temperature doesn't matter. To get liquid refrigerant out of the drum always turn the drum upside down. Liquid charging is also faster. Temperature is an important factor to consider in liquid charging. (TRUE or FALSE)



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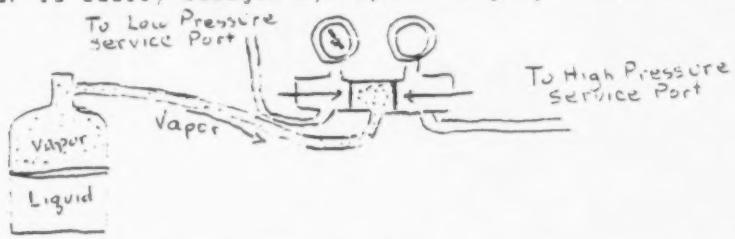
12. The advantage of vapor charging is that this method is much safer for the system's compressor. Vapor is charged into the low pressure side when the system is running. The refrigerant bottle must be upright when vapor charging.
The compressor is easily damaged by vapor charging. (TRUE or FALSE)



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11. False
12. False

13. In refrigerators it is sometimes possible to charge small amounts of liquid into the low pressure side of the system. When this is done be sure that the compressor is turned off and that the liquid has had time enough to vaporize out of the compressor and equalize pressure throughout the system before the unit is turned on.
When charging small amounts of liquid into the low pressure side of a refrigerator be sure that the compressor is turned _____.

---

14. Liquid refrigerant is never charged into the low side of systems with rotary compressors. Different system designs require different methods of charging, so it's always best to be familiar with the system's design and the manufacturer's suggestions.
Rotary compressor systems always require liquid charging in the _____ side.

---

13. off
14. high

15. Always be careful not to overcharge a system. Overcharging often causes the compressor to rattle or to make a pinging sound. If you hear this while charging, stop immediately. This sound may be an indication that the compressor is in a bind and that it may lock up.

Overcharging can cause damage to the _____.

---

16. Over charging a system causes: 1) too much head (high side) pressure, 2) Possible compressor damage, 3) a frozen suction line, 4) frost all the way back to the compressor on the suction line, and 5) higher than normal wattage and amperage.

— Too much head pressure in a system could possibly indicate what?

---

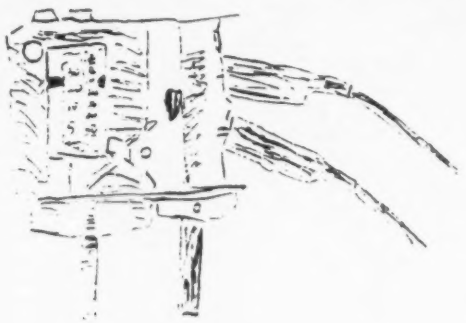
15. compressor

16. The system may be overcharged.

---

17. In a refrigeration system with a low pressure control it is impossible to start the compressor without jumping over or by-passing the low pressure contacts. Once pressure is built up, the by-pass can be removed and the contacts will remain closed. Always be sure to disconnect the by-pass after charging to avoid system damage.

In a system with low pressure controls what must be done to charge the system?



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18. There are two types of scales often used for weighing refrigerant. One is a dial scale and the other is a digital electronic scale. Electronic scales are more accurate but are also much more expensive.

Two types of scales used for weighing refrigerant are the _____ scale and the _____ scale.

---

17. Low pressure controls must be by-passed.

18. dial, electronic

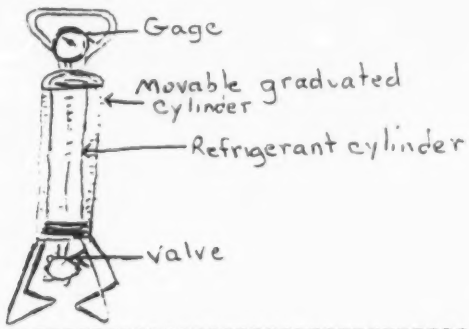
---

19. In using the dial scale, the refrigerant weight has to be calculated by subtracting the weight of the refrigerant drum from the total weight. One advantage of the electronic scale is that the drum weight can be allowed for by setting the scale back to zero, allowing for only the weight of the refrigerant to register. By doing this, calculations are not necessary.

    Calculations are not necessary when using the regular dial scale. (TRUE or FALSE)

---

20. The graduated (numbered) dial-a-charge cylinder holds up well under hard use and doesn't have to be calibrated like scales. The outside cylinder is dialed according to the kind of liquid refrigerant used and the existing temperature and pressure inside the cylinder according to the gage on the cylinder. No calculations have to be made. After the dial is set, valves are opened until the exact amount of liquid refrigerant enters the cylinder.



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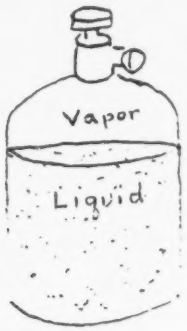
19. False
20. None

---

21. When filling a refrigerant drum, always allow for a 15% vapor space so that there is room for vapor expansion. If this is not done an explosion could occur.

In filling a drum with refrigerant you must not fill it more than _____ full.



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22. There are two frequently used short-cut methods of vapor charging. One is zero-point charging and the other is sight-glass charging.

Zero-point charging and sight-glass charging are two frequently used methods of _____ charging.

---

21. 85% (100 - 15)

22. vapor

23. Zero-point charging is used by the manufacturers to set a recommended charge amount. To zero-point charge: charge until the suction line frosts then release the refrigerant pressure until the frost pattern goes back to the evaporator outlet.

    To zero-point charge, charge until the _____ _____ frosts then release the pressure until the frost pattern goes back to the evaporator outlet.

---

24. In buying a graduated cylinder for liquid charging it is very important that you select one that is large enough for the systems you will be working with.

    _____ is an important factor to consider when buying a graduated cylinder. (Size, Shape)

---

23. suction line
24. Size

25. Sight-glass charging is the simplest and most widely used system of charging. It can only be done with thermostatic expansion systems which are variable charge systems.

Thermostatic expansion systems are _____ charge systems.

---

26. To use the sight-glass charge method you add refrigerant until the bubbles disappear in the sight-glass and you see clear liquid in the liquid line. When this happens your system is charged.

The liquid should be _____ in the liquid line sight glass when the system has been properly charged by the sight-glass charge method.

---

27. Capillary tube or automatic refrigeration systems cannot be charged by the sight-glass method because this type system is a critical charge system, which means that the charge must be exact.

In a critical charge system, the charge must be _____.

---

25. variable
26. clear
27. exact

JOB SHEET

ACR SYSTEM CHARGING

PREREQUISITES:

1. View video tape "System Charging"
2. Complete Programmed Instruction on "System Charging"

OBJECTIVE: Upon completion of this exercise, you will be able to add refrigerant to a charging cylinder and charge refrigerant into a typical refrigeration system using a charging cylinder.

TOOLS AND MATERIALS: A vacuum pump, gage manifold, goggles, gloves , refrigerant that is characteristic to the system, graduated charging cylinder, straight blade screwdriver, 1/4" and 5/16" nut drivers, and a refrigeration as described below.

INTRODUCTION: You will apply gages to a typical capillary tube refrigeration system, exhaust the charge and evacuate the system to a deep vacuum. you will then add enough charge to a charging cylinder, connect it to the system and measure in the correct charge. You will need to use a package system or one with a known charge, and one with service valves or Schrader valve ports.

SAFETY PRECAUTIONS: Wear gloves and goggles while transferring refrigerant to and from a system. DO NOT overcharge the charging cylinder. Follow all instructions carefully. Your instructor must give you instructions in using the gage manifold, adding refrigerant to the charging cylinder and to the system, using the vacuum pump and evacuating a system before you proceed with this exercise.

CRITERIA: Upon completion of this job sheet, have your resource person check your answers with the answer sheet. If you answer 10 out of 10 correct, then take POSTTEST on System Charging. If you miss any, see your instructor.

PROCEDURES:

1. Connect the gage lines to the service valves or Schrader valve ports on the high and low sides of the system and remove all refrigerant from the system to be charged. Your instructor will instruct you as to where and how to remove the refrigerant.

JOB SHEET/ System Charging Cont.

MAINTENANCE OF WORK STATION AND TOOLS: Check the vacuum pump oil and add if needed. Wipe up any oil in the work area. Return all tools to their respective places. Replace panels on the unit.

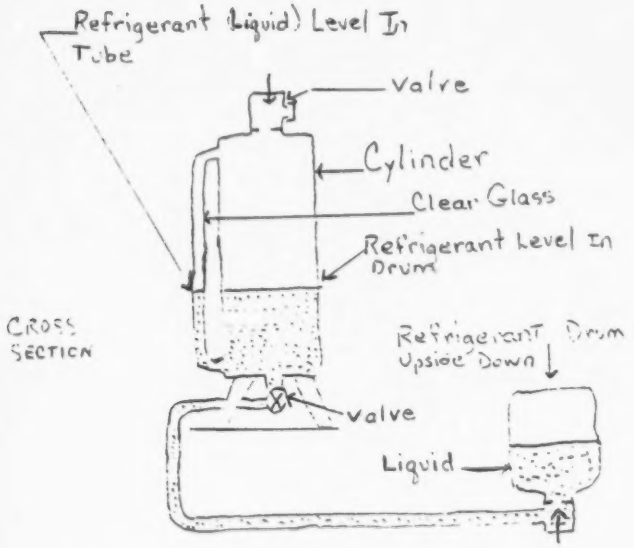


Figure A.

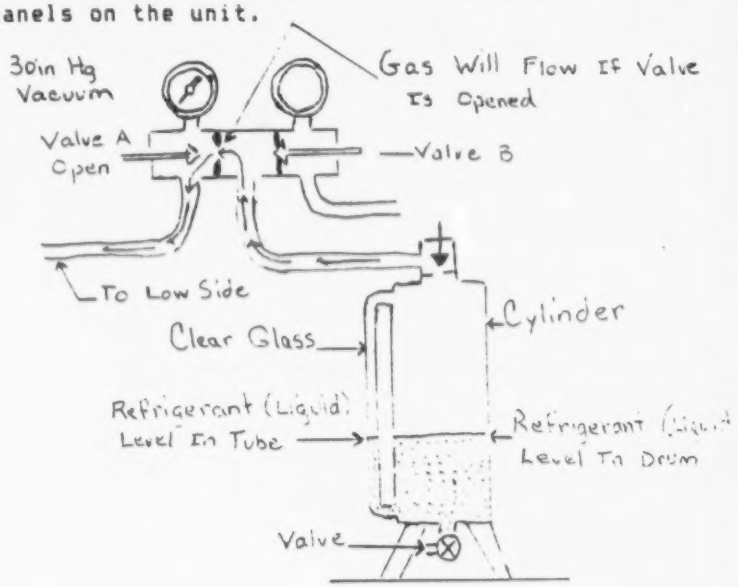


Figure B.

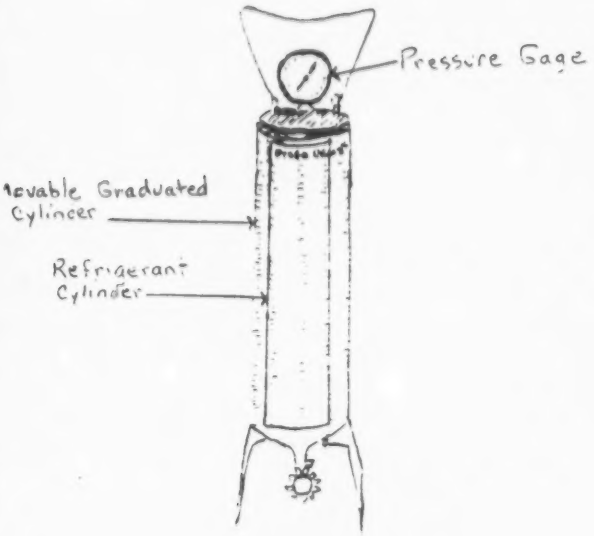


Figure C.

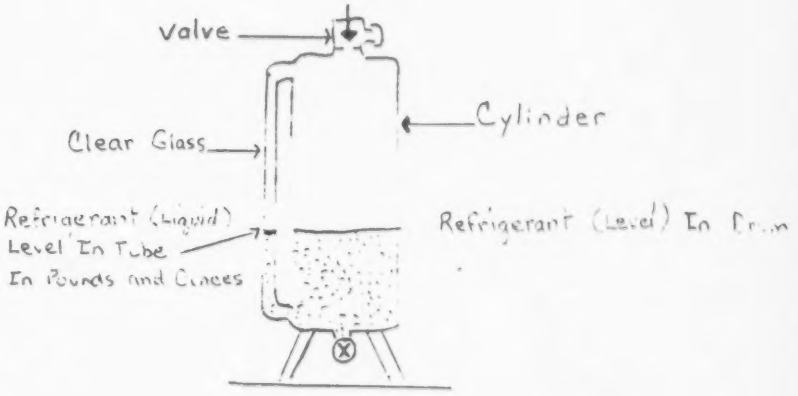


Figure D.

JOB SHEET/ System Charging cont.

2. Check the oil level in the vacuum pump, add oil if needed, connect it to the center line of the manifold and start the pump. Open the gage manifold valves..

3. Determine the correct charge for the system and write it here for a reference point. _____ ounces

4. While the evacuation is being performed, connect the charging cylinder to the drum of the refrigerant. See Figure A

5. When the charging cylinder has enough refrigerant to charge the system and the vacuum has reached the correct level (deep vacuum is determined by sound or instrument), you are ready to charge-the refrigerant into the system.

6. Shut off the vacuum pump and connect the charging cylinder as shown in Figure B.

7. Purge a small amount of refrigerant from the gage manifold line by loosening the center gage line at the manifold after the connection is made because some air will be drawn into the gage line when disconnecting from the vacuum pump.

8. Turn the outside cylinder on the charging station to correspond to the pressure in the cylinder. For example, if the pressure gage at the top of the cylinder reads 75 psig (this would be R-12), turn the dial to the 75 psig scale and read the exact number of ounces on the sight glass of the charging cylinder, Figure C. Record it here. _____ ounces

9. Subtract the amount of the unit charge from the charging cylinder level and record here. _____ ounces. This is the stopping point of the charge.

10. Open the vapor valve at the top of the cylinder and the low side valve on the gage manifold. The charge will begin to fill the system.

11. When the system is above 0 psig, disconnect the high-side gage line. The reason for this is that the charging cylinder pressure will soon equalize to the same pressure as the system and the refrigerant will stop flowing. You may have to start the system to pull in the correct charge. You do not want any condensed refrigerant in the high-side gage line. Some charging cylinders have a heater in the base to keep the pressure up and the system may not have to be started.

12. Keep adding refrigerant vapor until the correct low level appears on the sight glass on the charging cylinder (Figure D) and then shut off the suction valve on the gage manifold.

JOB SHEET QUESTIONS/ System Charging

1. What is the charging cylinder graduated in?

2. Why is it necessary to turn the dial to the correct pressure reading and use this figure for the charge?

3. What scale or graduation was the charge expressed in on the system you charged, pounds or pounds and ounces?

4. How many ounces are there in a pound?

5. How many ounces are there in one-fourth of a pound?

6. Why was the high-side line disconnected before starting the unit?

7. How may refrigerant be charged into the system if the drum pressure drops?

8. How do some charging cylinders keep the pressure from dropping as the charge is added?

9. What type of metering device normally requires an exact charge?

10. Do all systems have sight glasses in the liquid line to aid in charging?

ACR

SYSTEM CHARGING

JOB SHEET ANSWER SHEET

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

JOB SHEET ANSWERS

SYSTEM CHARGING

1. pounds and ounces

2. so that the volume will correspond to the correct pressure-temperature relationship

3. pounds and ounces

4. sixteen

5. four

6. because of the possibility of the loss of the charge when disconnecting the hose from the unit

7. Place the refrigerant drum into a tub of warm water to raise the temperature and pressure of the refrigerant.

8. Some charging cylinders have built-in electric heaters for this purpose.

9. the capillary tube

10. no

IF YOU GOT 10 OUT OF 10 CORRECT, GO ON TO THE POSTTEST. IF YOU MISSED ANY, GO OVER THE ANSWERS WITH YOUR INSTRUCTOR BEFORE GOING ON TO THE POSTTEST.

SYSTEM CHARGING

POSTTEST

1. Liquid charging by the use of a graduated cylinder is called _____ charging.

2. Vapor charging is accomplished on what side of the refrigerant system?
3. Adding the proper amount of refrigerant into a system is called _____ a system.

4. When a system is not operating, vapor can be added to either the high side or the low side of the system. (TRUE or FALSE)

5. To add vapor into the system, the pressure in the refrigerant drum must be _____ than the pressure in the low side of the system.

6. In vapor charging and liquid charging, which of the two are the more exact?

7. The refrigerant bottle must be _____ when you are liquid charging.

8. When the refrigerant system has _____ pressure controls you will have to use a by-pass over the contacts.

9. What should you do if you hear the compressor rattle while you are charging a refrigeration system?

10. _____ is the fluid in the refrigeration system that changes back and forth from vapor to liquid and from liquid to vapor according to the pressures in the system.

11. Outside or surrounding temperature is called _____ temperature.

12. What is the hottest that tub-water should be when heating a refrigerant bottle to increase pressure?

13. Is sight-glass charging a variable or a critical charge method?

14. In systems with _____ compressors, refrigerant is never charged into the low side of the system.

15. Charging until the suction line frosts then releasing refrigerant pressure until the frost pattern goes back to the evaporator outlet is called _____-_____ charging.

16. The charge must be exact on a _____ charge system. (critical, variable)

17. Adding refrigerant until the _____ disappear in the liquid line sight glass is a method of vapor charging.

18. The compressor must be turned _____ when charging liquid into the low pressure side of a refrigerator.

19. Capillary tube or automatic systems cannot be charged by the sight-glass method because this type system is a _____ charge system.

20. Liquid charging is normally accomplished in the liquid line on the _____ pressure side of the refrigerant system.

21. Vapor charging charges the system with a/an _____ amount of refrigerant. (exact, estimated)

22. Why is a 15% vapor space required when filling a drum with refrigerant?

23. What is the advantage of vapor charging?

24. What things can happen to the refrigeration system if it is overcharged?

25. What are the disadvantages of using electronic scales for weighing refrigerant?

26. What is the advantage of using a digital electronic scale instead of a dial scale?

SYSTEM CHARGING

POSTTEST ANSWER SHEET

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. 1) _____ 2) _____ 3) _____ 4) _____
25. 1) _____ 2) _____ 3) _____
26. _____

SEE NEXT PAGE FOR ANSWERS

SYSTEM CHARGING

POSTTEST ANSWERS

1. dial-a-charge
2. low
3. charging
4. True
5. higher being in a bind,
6. liquid
7. upside down
8. low
9. Stop charging immediately
10. refrigerant
11. ambient
12. 90 degrees F
13. variable
14. rotary
15. zero-point
16. critical
17. bubbles
18. off
19. critical
20. high
21. exact
22. To allow for expansion with increased ambient temperatures.
23. It is safer on the compressor.
24. 1)too much head pressure,
    2)possible compressor damage from
    3)suction line is frozen, and
    4)frost all the way back to the compressor on the suction line
25. 1) not durable
    2) frequent need of calibration
    3) initial expense
26. The scale can be set to zero so refrigerant drum weight doesn't have to be calculated in order to figure out the refrigerant weight

IF YOU MISSED MORE THAN THREE, GO BACK OVER THE PROGRAMMED INSTRUCTION.

The enclosed materials are designed to be used in conjunction with the Video-taped presentation of the classroom lectures and the instructor's cooperation. The materials included are:

1. Student Learning Guides
   These guides present an introduction to the lesson, the objectives of the lesson, and the specific activities available to provide learning to meet the objectives.

2. An Outline of the video presentation

3. Study questions to assist in the student's comprehension of the lesson.

4. Study pages pulled from the text, BASIC BLUEPRINT READING AND SKETCHING, which present material discussed in the video presentation.

5. A test preview covering the unit.

The Student Learning Guide series is not intended to be a self-contained learning package but a supplement to the instructor's supervision of the learning process.

For further clarification and understanding of the principles presented in these lessons, seek the instructor's help. The instructor can evaluate your problems and needs and assist you in obtaining any further resources, materials, or training designed to meet your specific learning needs.

Basic Blueprint Reading

SECTION 3: DIMENSIONS AND NOTES

RESOURCES:

Olivo, Payne and Olivo, BASIC BLUEPRINT READING AND SKETCHING, 5th ed., Delmar Publishers Inc. Albany, NY, 1988; Video Presentations with selected learning materials; Selected handouts.

Introduction:

The shape and internal construction of an object or mechanism is identified on a drawing by the use of several types of lines which are used singly or in combination. Exact sizes and locations of surfaces, indentations, holes and other details must be given regarding the lines for proper construction or machining of the part.

The language of drafting has been established by the American National Standards Institute (ANSI) to provide uniformity in industrial drawings.

In this section, units 11 through 21, you will be exposed to the principles and standards used to identify and exactly duplicate the project through the use of dimensions and notes.

Units of Study:

11. Size and Location Dimensions
12. Dimensioning Cylinders, Circles and Arcs
13. Size Dimensions for Holes and Angles
14. Location Dimensions for Points, Centers, and Holes
15. Dimensioning Large Arcs and Base Line Dimensions
16. Tolerances: Fractional and Angular Dimensions
17. Tolerances: Unilateral and Bilateral Tolerances, and Decimal Dimensions
18. Representing and Dimensioning External Screw Threads
19. Representing and Specifying Internal Left-Hand Threads
20. Dimensioning Tapers and Machined Surfaces
21. Dimensioning and Shop Notes

Objectives:

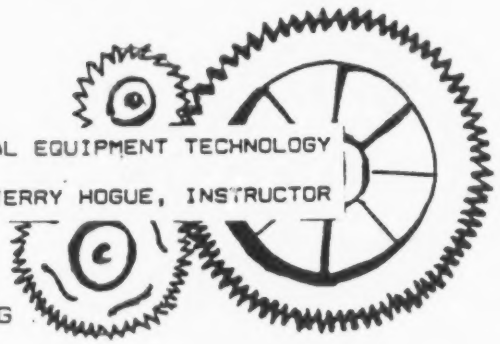
The student will demonstrate:

1. Identify and interpret blueprints using ANSI notations.
2. identify and interpret dimensions which indicate exact size and locations of surfaces.
3. identify and interpret dimensions detailing indentations, holes, and other details.

Evaluation

Evaluation of competency will be determined by the instructor through the student's interpretation and identification of dimension notations on actual drawings and through the completion of a written, objective test with a 76% or better success rate.

Votech



COURSE TITLE: BASIC BLUEPRINT READING

UNIT: 13 - SIZE DIMENSIONS FOR HOLES AND ANGLES

RESOURCES: Text, BASIC BLUEPRINT READING AND SKETCHING, 5th. ed., pp 52-55; Video Presentation with learning materials; Selected handouts.

COMPETENCY: READ AND INTERPRET BLUEPRINTS

INTRODUCTION:

The identification and labeling of holes and angles requires special notation. Placement of holes, dimensions, and special instructions for design are important for the accurate crafting of the object or part.

This unit introduces the student to terminology and procedures relating to holes and angles.

PERFORMANCE OBJECTIVE:

After completion of this unit, the student will be able to:

1. understand terminology relating to dimensioning holes
2. identify dimensions for counterbored holes
3. identify dimensions for countersunk holes
4. identify dimension for angles

EVALUATION:

Evaluation will be made on the students ability to interpret dimensions of holes as provided on a blueprint and through the scoring of 76% or better on a written, objective test.

LEARNING ACTIVITIES:

1. **ATTEND LECTURE** or **VIEW VIDEO** presentation of lecture.
2. **PARTICIPATE** in oral questioning session with instructor.
3. **COMPLETE EXERCISE** on pages 54 and 55.
4. **COMPLETE TEST** as provided by the instructor.

GENERAL INFORMATION:

The Student Learning Guide is designed to provide an individualized, self-paced learning guide for the student. Learning activities should be completed in the order given to provide comprehensive understanding of the material. The guide is designed to supplement classroom activity--not to replace it. Teacher/student cooperation is important to establish achievement of the particular competency involved.

Additional resource material and training activities will be provided by the instructor upon request to meet each student's needs.

UNIT 13 - SIZE DIMENSIONS FOR HOLES AND ANGLES

- PRESENTATION OUTLINE -

I. Dimensioning Holes

- A. The operation
- B. The number of holes

II. Counterbored Holes

- A. Leader line
- B. depth
- C. Symbol

III. Countersunk Holes

- A. Diameter
- B. Angle
- C. symbol

IV. Dimensioning Angles

- A. Linear Dimension
- B. Angle dimension
- C. Measurement of angle

V. Review through identification

REVIEW QUESTIONS

UNIT 13 - SIZE DIMENSIONS FOR HOLES AND ANGLES

1. What are the three operations described for forming holes?

   1.

   2.

   3.

2. What is a "counterbored hole"?

3. What symbol is used to designate that a hole is to be counterbored?

4. What symbol is used to identify the depth of a hole?

5. What is meant by the term "countersunk," and how is it different from "counterbored"?

6. What symbol is used to indicate that a hole is to be countersunk?

7. Explain the difference between linear dimensions and angular measurement?

APPENDIX B

Budget

Multimedia Approach to Self-Paced Individualized Instruction In Air Conditioning, Refrigeration and Heating And Other Vocational Programs

VI. BUDGET

TITLE: Multi-media Approach to Self-Paced Individual Instruction In Air Conditioning, Heating and Refrigeration and Other Vocational Programs

PROJECT DURATION: July 1, 1988 - June 30, 1989

APPLICANT: Oil Belt Vo-Tech School

Budget Categories	Funds Requested	Local Contribution
A. Personnel		
(1) Project Coordinator Full time for 12 months	18,434.00	
(2) Project Aide 900 hours @ $4.50	4,050.00	
(3) Adminstrative and support staff		4700.00
B. Employee Benefits		
(1) Social Security	1313.00	
(2) Teacher Retirement	2359.00	
(3) Unemployment and Worker's Compensation	123.00	
(4) Group Insurance	960.00	
C. Travel		300.00
D. Maintenance and Operations		
(1) Office Supplies		1100.00
(2) Instruction Materials		4500.00
E. Instructional Equipment	2300.00	
F. Reproduction and Dissemination		200.00
TOTAL	29,539.00	10,800.00

VI. BUDGET

TITLE: Multi-media Approach to Self-Paced Individual Instruction In Air Conditioning, Heating and Refrigeration and Other Vocational Programs

PROJECT DURATION: July 1, 1987 - June 30, 1988

APPLICANT: Oil Belt Vo-Tech School

Budget Categories	Funds Requested	Local Contribution
A. Personnel		
(1) Project Coordinator Full time for 12 months	17,472.00	
(2) Project Aide 900 hours @ $4.50	4,050.00	
(3) Administrative and support staff		4500.00
B. Employee Benefits		
(1) Social Security	1313.00	
(2) Teacher Retirement	2359.00	
(3) Unemployment and Worker's Compensation	123.00	
(4) Group Insurance	960.00	
C. Travel		300.00
D. Maintenance and Operations		
(1) Office Supplies		1000.00
(2) Instruction Materials		4500.00
E. Instructional Equipment	7100.00	
F. Reproduction and Dissemination		200.00
TOTAL	33,377.00	10,500.00